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XLVII. *A Letter from Richard Price,
D. D. F. R. S. to Benjamin Franklin,
L L. D. F. R. S. on the Effect of the
Aberration of Light on the Time of a
Transit of Venus over the Sun.*

DEAR SIR,

Read Dec. 20. 1770. I Cannot doubt but that the observation made by your ingenious friend in the paper * you sent me is right. The aberration of Venus must, I think, affect the phases of a transit, by retarding them, and not by accelerating them. This retardation is $55\frac{1}{2}''$; for that is the time nearly which Venus, during a transit, takes to move over $3''.7$. This, however, is by no means the whole retardation of a transit occasioned by aberration. There is a retardation arising from the aberration of the Sun, as well as from that of Venus. The aberration of the Sun, it is well known, lessens its longitude about $20''$. and the aberration of Venus, agreeably to your friend's demonstration, increases its longitude at the time of a transit $3''.7$. Venus, therefore, and the Sun, at the instant of the true beginning of a transit, must be separated from one another by aberration $23''.7$; and, since Venus then moves nearly at the rate of $4'$ in an

* The paper which occasioned this letter, and which is here referred to, may be found in p. 358 of this volume.

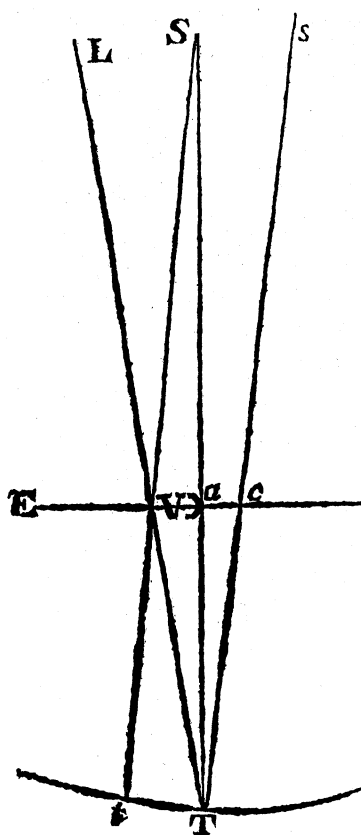
hour,

hour, it will move over $23''.7$ in $5':55''$. And consequently, from the instant of the *real* beginning of a transit, $5':55''$ must elapse before it can begin *apparently*.

It may, I know, be objected here, that the aberration of the Sun ought not to be taken into consideration, because the calculations from the solar tables give the apparent places of the Sun, or its longitude with the effect of aberration included, and therefore always about $20'$ too little. But from this observation a conclusion will follow very different from that which the objection supposes. The retardation I have mentioned is properly the time that the calculated phases of a transit of Venus will precede the apparent phases, supposing the tables from which the calculation is made to give the true places of the Sun.

If they give the apparent places of the Sun, this retardation, instead of being lessened, will be considerably increased. In order to prove this, I must desire it may be remembered, that in deducing by trigonometrical operations the geocentric places of a planet from the heliocentric, the Earth is supposed to be in that point of the ecliptic which is exactly opposite to, or 180° from the place of the sun, and that this supposition is just only when the sun's true place is taken. In reality, the Earth is always about $20''$ more forward in its orbit than the point opposite to the Sun's apparent place; and in consequence of this it will happen, that in calculating a transit of Venus from tables which give the Sun's apparent places, a greater difference will arise between the calculated and the observed times than if the tables had given the Sun's true places.

For, let S be the Sun, T the Earth, V Venus. Were there no aberration of light, the Sun would be always seen in its true place, or in the direction TS . But, in reality, in consequence of aberration, it will be seen $20''$ less advanced in the ecliptic, or in the direction Ts , supposing STs to be an angle of $20''$. Now a calculation from tables giving the true places of the Sun, would fix the moment of a conjunction, to the time that Venus gets to TS ; but this, though the time of the true conjunction, would not be the time of the observed conjunction; for the Sun being then really seen in the direction Ts , Venus, after getting to TS , must move $20''$, or from a to c , before the apparent conjunction can take place.



But if the calculations are made from the apparent places of the Sun, the conjunction will be fixt to the time Venus gets to tS , or a line drawn through S parallel to sT , for in this case t will be the point of the ecliptic opposite to the apparent place of the Sun, and the longitude of the sun seen from t will be $20''$ less than its true longitude, and therefore the same with its apparent longitude. But the Earth being then really at T , Venus will, at the calculated time of a conjunction, be observed at a distance from the Sun equal to the angle $L Ts$. This angle, supposing $V T 277$, and $V S 723$, may be easily found

found to be $72''.2$. Add to this $3''.7$, the proper aberration of Venus at the time of a transit, removing it more towards E, and the whole visible distance of Venus from the Sun's center at the calculated moment of a conjunction, will be $75''.9$, over which it will move in 19 minutes of time. And this, consequently, will be the retardation of the phases of a transit of Venus occasioned by aberration, on the supposition, that in calculating, the Sun's apparent, and not his true place is taken.

I believe these observations have not been attended to by astronomers ; and therefore I am the more desirous of communicating them to you.

I am,

Dear Sir,

with much respect,

your obliged humble servant,

Richard Price.

P. S. In a former letter which I sent you, I gave, by mistake, the error occasioned by aberration less than I have now given it. The discovery of this mistake I owe to the kind assistance and correction with which Mr. Maskelyne, the astronomer royal, has been pleased to favor me.

I have, for the sake of more distinctness and clearness, supposed Venus to move in the plane of the ecliptic. Some differences will arise from the inclination of the path of Venus to the ecliptic, and also from taking the aberration of the Sun, and the proportion of Venus's distance from the Earth to her distance from the Sun, exactly as they really are at the time of a transit. Thus, at the time of the last transit of Venus, supposing light to come from the Sun to the Earth in $8', 2$, the aberration of the Sun was $19''.8$. The distance of Venus from the Earth was to its distance from the Sun as 290 to 726, and therefore the retardation $18' : 16''$.

Mr. Canton has observed, that in the *Con. des Temp.*, Mr. De la Lande makes the effect of aberration at the inferior conjunction of Venus and Mercury to be an augmentation of their longitudes. Indeed, Mr. Bliss himself observes this; and yet, through an oversight, makes the effect as to time to be an acceleration. Vid. Phil. Transf. vol. LII. p. 249.